Please note: This documentation covers a large dataset separated into four individual accessions to provide greater ease of downloading the data.

Data Documentation

Dataset Information

Dataset Title:

NOAA RESTORE Science Program: A Web-based Interactive Decision-Support Tool for Adaptation of Coastal Urban and Natural Ecosystems (ACUNE) in Southwest Florida: Episodic Water Level Monitoring in Clam Bay from 2018-06-10 to 2020-01-07

NOAA RESTORE Science Program: A Web-based Interactive Decision-Support Tool for Adaptation of Coastal Urban and Natural Ecosystems (ACUNE) in Southwest Florida: Episodic Water Level Monitoring in Goodland from 2018-06-10 to 2020-01-09

NOAA RESTORE Science Program: A Web-based Interactive Decision-Support Tool for Adaptation of Coastal Urban and Natural Ecosystems (ACUNE) in Southwest Florida: Episodic Water Level Monitoring in Henderson Creek and Rookery Bay from 2018-06-10 to 2020-01-10

NOAA RESTORE Science Program: A Web-based Interactive Decision-Support Tool for Adaptation of Coastal Urban and Natural Ecosystems (ACUNE) in Southwest Florida: Episodic Water Level Monitoring in Ten Thousand Islands from 2018-06-10 to 2020-01-08

Description:

This dataset includes in situ observations of water level collected at a high temporal resolution. Observations were collected at 28 sites along the Southwest Coast of Florida from Naples to the Ten Thousand Islands National Wildlife Preserve from 2018-06-10 to 2020-01-10. Included in this dataset are:

- 4 sites in Clam Bay;
- 8 sites in Goodland;
- 6 sites in Henderson Creek and 2 sites in Rookery Bay; and
- 8 sites in the Ten Thousand Islands.

Sensors were surveyed by RTK GPS and were vertically positioned at locations estimated to be slightly above local Mean High High Water targeting the collection of data during higher-than-normal water level, episodic events only (e.g. astronomically higher tides, tropical storms, etc.). Although the sensors were deployed during the 2018 and 2019 Atlantic Hurricane season, no tropical storm events were recorded. However, several small astronomically high tide events were observed. The primary variable being observed was water pressure when the sensors were immersed.

Purpose:

Southwest Florida contains the largest area of tidally influenced public lands in the Gulf of Mexico and the fastest growing urban landscape in Florida. Both the human and natural components of the ecosystem are under increasing risk due to the threats of a growing human

population, sea level rise, and tropical cyclones. The project "A Web-based Interactive Decision-Support Tool for Adaptation of Coastal Urban and Natural Ecosystems (ACUNE) in Southwest Florida" created inundation, salinity distribution, habitat distribution maps, beach and barrier islands vulnerability, and economic impacts maps for various climate and sea level rise scenarios and integrated the maps into a web-based interactive decision-support tool that enables users to identify areas of high vulnerability. The intent of this dataset was to provide water level data for use in the verification and validation of the tide, surge, and wave modeling components of ACUNE through observations collected during episodic, higher-than-normal water level events (e.g. astronomically higher tides, tropical storms, etc.). Working with local governments, a decision-support tool was developed to aid resource managers with preservation and restoration of mangrove, marsh, and beach habitats and mitigation of future salt-water intrusion in estuaries and their associated habitats. This was accomplished in two steps. First, a suite of coupled state-of-the-art models was used to create inundation, salinity distribution, habitat distribution, beach and barrier islands vulnerability, and economic impact maps for current and future climate and for various sea level rise scenarios. The maps were then integrated into a web-based interactive decision-support tool that enables users to identify areas of high vulnerability. To ensure the tools use, end-users were trained on how to use the tool. The tool allows local governments to make strategic decisions on coastal planning, zoning, land acquisition, and restoration for coastal resiliency.

The data in this accession were funded by the NOAA RESTORE Science Program under award NA17NOS4510094 to the University of Florida.

Methods:

To capture the episodic higher-than-normal water level events necessary for model verification and validation, 28 sensors were designed and built from scratch and then deployed/recovered twice. The sensors were deployed in four locations in Southwest Florida: Clam Bay (4), Goodland (8), Henderson Creek / Rookery Bay (8), and in the Ten Thousand Islands (Figure 1). These sensors were designed to deployed vertically out of the water with a triggered to enable them only when an event occurred (Figure 2 and Figure 3). This ensured maximum battery life (without the need of a solar panel) and minimal biologic growth both of which were highly useful as many of the deployment locations were remote and teeming with wildlife.

Once immersed, the sensors recorded the absolute pressure of the water column above the sensor (which is ultimately converted to water level). The sensors were encased in Schedule-40 PVC which incorporated a PVC union to enable them to be opened while remaining waterproof in the field. The pressure sensors were calibrated in a laboratory with the distance from the pressure sensor port to the top of the union collar determined. Immediately prior to a deployment, the internal highly accurate, temperature compensated RTC (~2 s/yr) was set and the sensor sealed.

The sensors were deployed by affixing them to strongly rooted, mature mangroves or trees to ensure they wouldn't move even during extreme storm events (Figure 4). Pictures of the mounted sensors were taken and the sensors positions were surveyed to the top of the union collar with an RTK GPS system. This enabled to vertical position of the derived water level to be referenced to NAVD88. Sensors were configured to record at 128 hz which enables the resolution of waves, tides and surge. Locations for the sensors were determined during an exploratory visit to the region in mid-2018. Site spatial locations were chosen in a manner to

attempt to provide both alongshore and cross-shore tracks. Vertical locations were chosen by estimating the MHHW lines and chose locations 10-20cm above that.

For the first deployment, the sensors were deployed at the beginning of the 2018 Atlantic Basin hurricane season and then recovered the following May. For the second deployment, the sensors were deployed several months later in the 2019 hurricane season and then recovered in Jan 2020. Preliminary analysis of the data for the first deployment determined that the vertical locations on several sensors were higher than expected astronomical tides as few events were recorded. Thus, the vertical locations of these sensors were lowered for the second deployment. The spatial positions of all sites remained the same for both deployments. Although no tropical storms were observed, several astronomically higher-than-normal water levels events were recorded.

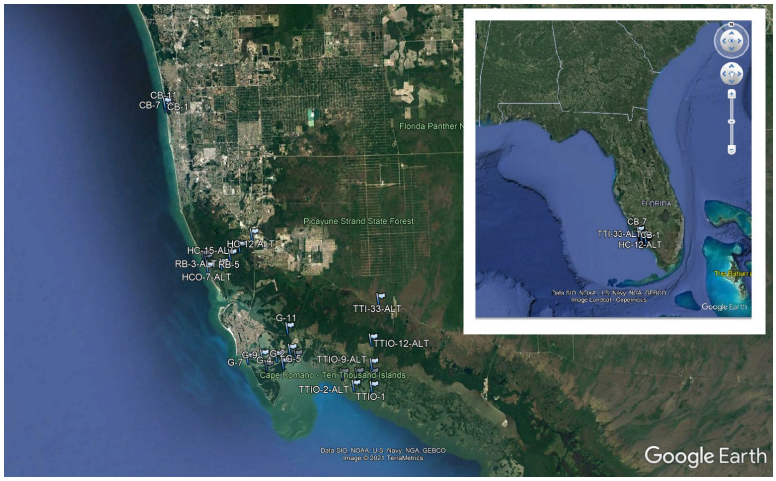

Figure 1 Sensor Locations in Clam Bay (CB), Henderson Creek (HC) / Rookery Bay (RB), Goodland (G) and Ten thousand Islands (TTI).

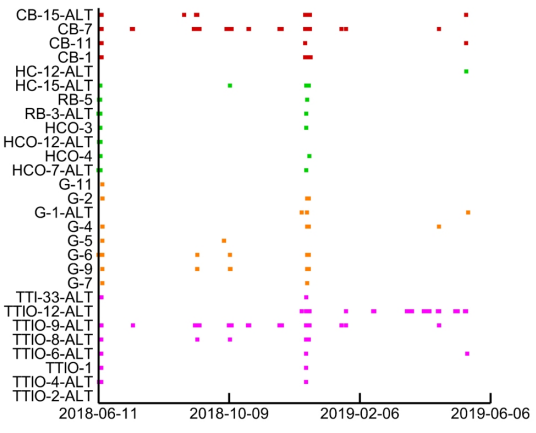

Figure 2 Availability of episodic water level data for the first sensor deployment.

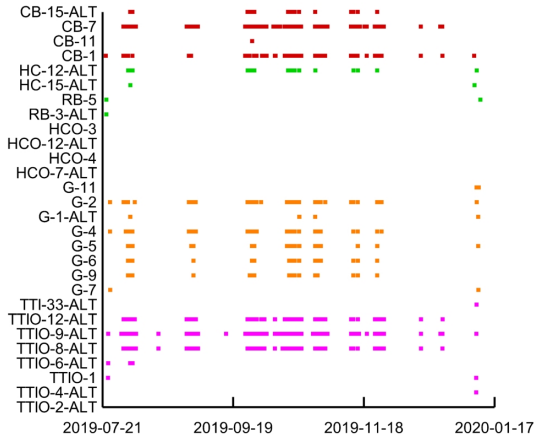

Figure 3 Availability of episodic water level data for the first sensor deployment.

a) 

b) 

Figure 4 Example deployment locations: a) mangrove forest and b) barrier island.

Observed pressure data is encrypted and the stored on high-capacity SD card located inside the sensor with each detected event saved as a separate file. After a deployment, the sensors were opened, data recovered, and then post-processed. The first intermediate post-processing step includes unpacking and decrypting the data, determining the time of each observation, and conversion of observation units. Then as a final post-processing step, water pressure measurements were converted to a delta water level above the sensor using a hydrostatic approximation. Time varying air pressure used in the conversion were obtained from three nearby NCEI sites. Each sensor was provided with a preferential ordering of the site in case data for a particular time-period was missing. With the delta water level determined, this value was adjusted to be referenced to the collar of the union, the location at which the GPS fixes to Geoid12a (NAVD88) were made. As the sensors were mounted to potentially growing vegetation, fixes were obtained at both deployment and recovery. For the vertical reference datum conversion from the top of the collar to NAVD88, the vertical position of the collar was assumed to move linearly from deployment to recovery.

While the horizontal accuracy of the GPS fixes was good for the needed resolution, in some cases, the vertical accuracy was reported to be on the order of several cm, however, in other cases, the accuracy was 50 cm. Thus, the conversions to the NAVD88 become somewhat questionable until the point at which they can be further compared with simulated water levels. Unfortunately, vertical inaccuracies are a common probably with remote coastal sites as the ability to take sight lines or to triangulate the RTK is limited. In general, the post-processed GPS fixes were reported to be less accurate. As such, although nearly all the sensors report reasonable vertical heights, it is still recommended to demean the data and focus on relative change in water level and/or the magnitudes/periods of recorded waves. Due to the high sample rate, the events being individually recorded, and the large number of events recorded, an additional optional post-processing utility was developed to extract data for one or more sensors for all events occurring in a specific time-period. This utility then output data in a format compatible with Tecplot (see example plots in Figure 5), although it would be easily adaptable to output a different data format. Intermediate and final post-processed data has been included. Additionally, some example data plots as well as plots showing the time-period in which the events occurred have been supplied as well.

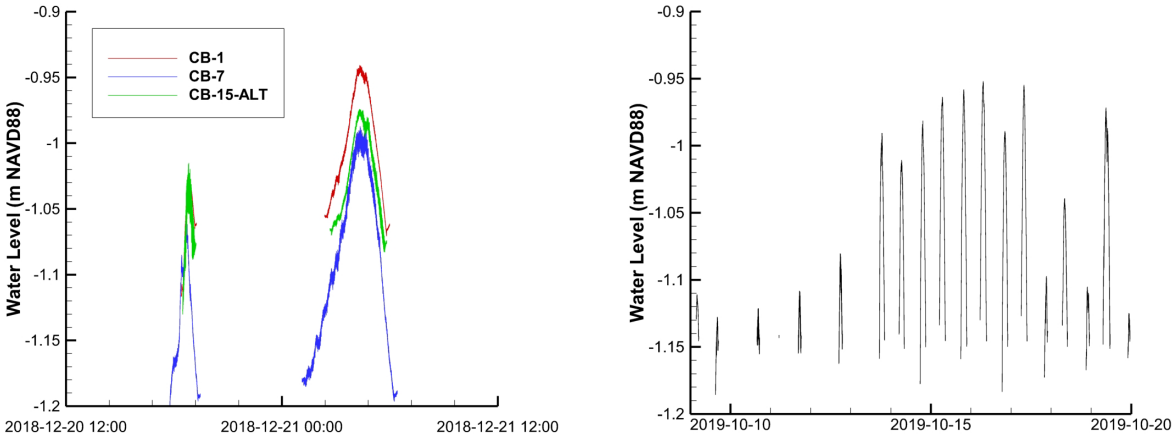

Figure 5 Examples of observed water level: a) Clam Bay in 2018 and b) Site TTIO-9-ALT in 2019.

Data Sources:

- NOAA NCEI Climate Data Office (CDO). 2020. Integrated Surface Dataset (Global), Marco Island, FL US, Station 72104199999, Sea Level Pressure (SLP), 2018-01-01 to 2020-10-26. NOAA National Centers for Environmental Information. Dataset. https://www.ncei.noaa.gov/access/search/data-search/global-hourly?stations=72104199999&startDate=2018-01-01T00:00:00&endDate=2020-10-26T23:59:59
- NOAA NCEI Climate Data Office (CDO). 2020. Integrated Surface Dataset (Global), Naples Municipal Airport, FL US, Station 72203812897, Sea Level Pressure (SLP), 2018-01-01 to 2020-10-27. NOAA National Centers for Environmental Information. Dataset. https://www.ncei.noaa.gov/access/search/data-search/global-hourly?stations=72203812897&startDate=2018-01-01T00:00:00&endDate=2020-10-27T23:59:59
- NOAA NCEI Climate Data Office (CDO). 2020. Integrated Surface Dataset (Global), Rookery Bay Reserve, FL US, Station 99800899999, Sea Level Pressure (SLP), 2018-01-01 to 2020-10-26. NOAA National Centers for Environmental Information. Dataset. https://www.ncei.noaa.gov/access/search/data-search/global-hourly?stations=99800899999&startDate=2018-01-01T00:00:00&endDate=2020-10-26T23:59:59

People & Projects

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Partners:

- Ten Thousand Island National Wildlife Refuge

Funding:

- US DOC; NOAA; NOS; National Centers for Coastal Ocean Science (NCCOS)
- US DOC; NOAA; NOS; NCCOS; RESTORE Science Program

Associated Online Resources:

- National Centers for Coastal Ocean Science, 2020: RESTORE Sponsored Research Project: A Web-Based Interactive Decision-Support Tool for Adaptation of Coastal Urban and Natural Ecosystems (ACUNE) in Southwest Florida, https://inport.nmfs.noaa.gov/inport/item/58981
- RESTORE Project, A Web-Based Interactive Decision-Support Tool for Adaptation of Coastal Urban and Natural Ecosystems (ACUNE) in Southwest Florida, https://restoreactscienceprogram.noaa.gov/projects/local-coastal-tool
- Sharp, S., P. Norby, and C. Angelini. 2020. NOAA RESTORE Science Program: A web-based interactive decision-support tool for Adaptation of Coastal Urban and Natural Ecosystems (ACUNE) in southwest Florida: measured and laser-scanned vegetation structure from 2017-11-27 to 2017-12-02 (NCEI Accession 0222471). NOAA National Centers for Environmental Information. Dataset. https://doi.org/10.25921/q9mn-d869
- Sheng, Y.P., V.A. Paramygin, and J.R. Davis. In prep. NOAA RESTORE Science Program: A Web-based Interactive Decision-Support Tool for Adaptation of Coastal Urban and Natural Ecosystems (ACUNE) in Southwest Florida: Flood Maps for current conditions, 2030, 2060 and 2100 under different sea level rise scenarios. To be submitted to NOAA National Centers for Environmental Information.

Extents

Start Date: 2018-06-10
End Date: 2020-01-10

Clam Bay:	2018-06-10 to 2020-01-07
Goodland:	2018-06-10 to 2020-01-09
Henderson Creek and Rookery Bay:	2018-06-10 to 2020-01-10
Ten Thousand Islands:	2018-06-10 to 2020-01-08

Northern Boundary: 26.21893 (Site CB-7)
Southern Boundary: 25.85546 (Site TTIO-1)
Western Boundary: -81.81687 (Site CB-11)
Eastern Boundary: -81.52752 (Site TTI-33-ALT)

Clam Bay:	NB 26.21893; SB 26.21115; WB -81.81687; EB -81.81255
Goodland:	NB 25.93162; SB 25.88501; WB -81.71101; EB -81.64444
Henderson Creek and Rookery Bay:	NB 26.05002; SB 26.01016; WB -81.76898; EB -81.70059
Ten Thousand Islands:	NB 25.96483; SB 25.85546; WB -81.58085; EB -81.52753

Keywords

Scientific Terms:

- Mangrove
- Marsh
- Beach
- Waves
- Water Level

Sea Areas, Water Bodies, Marine Protected Areas:

- Gulf of Mexico
- Clam Bay, FL
- Naples, FL
- Marco Island, FL
- Goodland, FL
- Rookery Bay National Estuarine Research Reserve
- Ten Thousand Islands National Wildlife Refuge

NCCOS Keywords:

- NCCOS Research Location > Region > Gulf of Mexico
- NCCOS Research Location > U.S. States and Territories > Florida
- NCCOS Research Data Type > Field Observation

File Information

Total File Size:

Clam Bay:	87.3 GB total, 697 files in 62 folders (unzipped), 14.8 GB (zipped)
Goodland:	44.1 GB total, 1139 files in 94 folders (unzipped), 7.12 GB (zipped)
Henderson Creek and Rookery Bay:	25.0 GB total, 304 files in 94 folders (unzipped), 4.15 GB (zipped)
Ten Thousand Islands:	70.2 GB total, 1055 files in 90 folders (unzipped), 11.6 GB (zipped)

Data File Format(s):

- Text (.ASCII, .TXT)
- Comma-separated value (.CSV)

Data Files:

- /01_Sensor_Data_[Location] - All of the post-processed sensor data as well all of the intermediate data files organized in various directories (see readme-main.txt)
  - /[Location]_[Year]_intermediate - Intermediate post-processing products. Includes ASCII versions of raw, encrypted binary data files and CSV versions of *.ASCII files with units and time converted.
    - /[Station]/[Sensor]/[Episode].DAT.DECRYPTED.ASCII
    - /[Station]/[Sensor]/[Episode]-tpv.CSV
  - /[Location]_[Year]_final - The final usable pressure and water level products (.csv).
    - /[Station]/[Sensor]/[Episode].CSV
- /02_GPS_Data - GPS Data locations of each sensor taken at the sensor collar
  - /geoid12a - used for NAVD88
    - /In-situ - RTK (*_RTK) (used)
      - 2018-06_RTK: First Deployment Installation
      - 2018-07_RTK: Maintenance Trip (re-survey)
      - 2018-08_RTK: Maintenance Trip (sock installation)
      - 2019-05_RTK: Recovery
      - 2019-07_RTK: Second Installation
      - 2020-01_RTK: Recovery
    - /Post-processed (*_PPK) (provided for reference)
  - /geoid18 (provided for reference)
  - Summary-lat-lon.ODS - Summary of the lat/lon positions of the installation and recovery GPS data used
- /03_NCEI_CDO_Data - NCEI CDO observational data used to obtain air pressure used to convert from water pressure to water level
  - 72104199999-MarcoIsland_combined-2018-2020.CSV
  - 72203812897-Airport_combined-2018-2020.CSV
  - 99800899999-RBNERR_combined-2018-2020.CSV

Documentation Files:

- DataDocumentation.PDF
- BrowseGraphic_[Location].JPG
- Figure1_SensorLocations.JPG
- Figure2_Availability_20180611-20190606.JPG
- Figure3_Availability_20190721-20200117.JPG
- Figure4a_Deployment_MangroveForest.JPG
- Figure4b_Deployment_BarrierIsland.JPG
- Figure5a_Observations_ClamBay2018.JPG
- Figure5b_Observations_TTIO9ALT2019.JPG
- Figure6_TTIO-oct-15to17-2019.jpg
- Sensor_[Station].JPG
- photos-of-sensors-insitu.PDF - Maps showing the locations of all 28 sensors as well as photos taken during all visits to the field sites.
- readme-main.txt
- readme-NCEI_CDO_Data.txt

Parameter Description:

Parameters: Water Level
Property Type: measured
Units: m
Observation Category: in situ
Sampling Instrument: water level sensor
Sampling and Analyzing Method:

28 sensors were designed and built from scratch and then deployed/recovered twice. Sensors recorded the absolute pressure of the water column above the sensor (which is ultimately converted to water level). Sensors were configured to record at 128 hz which enables the resolution of waves, tides and surge. After a deployment, the sensors were opened, data recovered, and then post-processed. The first intermediate post-processing step includes unpacking and decrypting the data, determining the time of each observation, and conversion of observation units. Then as a final post-processing step, water pressure measurements were converted to a delta water level above the sensor using a hydrostatic approximation. Time varying air pressure used in the conversion were obtained from three nearby NCEI sites.

Data Quality Method:

The pressure sensors were calibrated in a laboratory with the distance from the pressure sensor port to the top of the union collar determined. Each sensor was provided with a preferential ordering of the site in case data for a particular time-period was missing. With the delta water level determined, this value was adjusted to be referenced to the collar of the union, the location at which the GPS fixes to Geoid12a (NAVD88) were made. As the sensors were mounted to potentially growing vegetation, fixes were obtained at both deployment and recovery.

Table 1: Number of Episodes

Site	First Deployment			Second Deployment			Total Episodes
	Start Date	**End Date**	**Episodes**	**Start Date**	**End Date**	**Episodes**	
CB-1	06/13/2018	12/21/2018	6	07/19/2019	01/07/2020	53	59
CB-7	06/13/2018	04/19/2019	30	07/19/2019	12/24/2019	73	103
CB-11	06/13/2018	05/14/2019	4	07/19/2019	09/27/2019	2	6
CB-15-ALT	06/10/2018	05/14/2019	16	07/19/2019	11/24/2019	19	35
G-1-ALT	12/14/2018	05/16/2019	4	07/18/2019	01/09/2020	20	24
G-2	06/14/2018	12/21/2018	4	07/19/2019	01/08/2020	45	49
G-4	06/10/2018	04/19/2019	15	07/19/2019	11/26/2019	41	56
G-5	06/14/2018	10/04/2018	2	07/19/2019	01/09/2020	87	89
G-6	06/11/2018	12/21/2018	8	07/19/2019	11/24/2019	60	68
G-7	06/14/2018	12/19/2018	2	07/19/2019	01/09/2020	3	5
G-9	06/10/2018	12/21/2018	7	07/19/2019	11/24/2019	45	52
G-11	06/14/2018	06/14/2018	1	06/14/2018	06/14/2018	1	2
HC-12-ALT	06/10/2018	05/14/2019	2	07/19/2019	01/08/2020	22	24
HC-15-ALT	06/12/2018	12/21/2018	10	07/19/2019	01/07/2020	4	14
HCO-3	06/12/2018	12/18/2018	2	07/18/2019	07/18/2019	1	3
HCO-4	06/12/2018	12/21/2018	3	07/18/2019	07/18/2019	1	4
HCO-7-ALT	06/11/2018	12/18/2018	4	07/19/2019	07/19/2019	1	5
HCO-12-ALT	06/11/2018	06/12/2018	3	07/18/2019	07/18/2019	1	4
RB-3-ALT	06/11/2018	12/18/2018	5	07/19/2019	07/22/2019	2	7
RB-5	06/11/2018	12/19/2018	6	07/19/2019	01/10/2020	3	9
TTI-33-ALT	06/10/2018	12/18/2018	4	07/19/2019	01/08/2020	2	6
TTIO-1	06/13/2018	12/18/2018	4	07/19/2019	01/08/2020	4	8
TTIO-2-ALT			0	07/19/2019	07/19/2019	1	1
TTIO-4-ALT	06/11/2018	12/18/2018	4	07/19/2019	01/08/2020	2	6
TTIO-6-ALT	06/13/2018	05/15/2019	5	07/18/2019	08/03/2019	6	11
TTIO-8-ALT	06/13/2018	12/21/2018	6	07/18/2019	12/24/2019	67	73
TTIO-9-ALT	06/13/2018	04/19/2019	26	07/18/2019	01/08/2020	93	119
TTIO-12-ALT	12/14/2018	05/14/2019	35	07/18/2019	12/24/2019	62	97
Total	**218**			**721**			**939**

Table 2: Data Dictionary for Intermediate [Episode].DAT.DECRYPTED.ASCII files

Column	Variable	Example	Units
1	Start Data String	0xaabbccdd	
2	Message Type	0x10	
3	Message Version	0xa	
4	MAC Address	0xffffffffffff	
5	Archive Flag	1	
6	Quality Flag	0	
7	Number of Sensor Channels	4	
8	Number of Electrical Channels	1	
9	Time epoch (us)	3	
10	Time epoch (s since 1/1/1900)	1528922720	
11	Observation Freq (hz)	128	Hz
12	Observation count	0	
13	Pressure (PSI) * 1E6	14500759	PSI
14	Battery voltage (v)	12324230	v
15	Sensor Current (ma)	2700	ma
16	CRC-16-CCITT Checksum	0	

Table 3: Data Dictionary for Intermediate [Episode]-tpv.CSV files

Column	Variable	Example	Units
1	Observation Time in UTC	2018-06-13T20:45:20.000000	
2	Epoch Time (s since 1900)	1528922720	
3	Pressure (PSI)	14.50076	PSI
4	Battery Voltage (v)	12.32423	v

Table 4: Data Dictionary for Final [Episode].CSV files

Column	Variable	Example	Units
1	Observation time (UTC)	2018-06-13T20:45:20.000000	
2	Sensor Pressure (psi)	14.50076	PSI
3	Air Pressure (psi)	14.75759	PSI
4	Delta Water Level (m)	-0.00294	m
5	Water Level to Sensor Collar (m)	-0.23829	m
6	Water Level to NAVD 88 (m)	-1.10761	m

Document Information

Date: 2021-12-08

Resource Provider: NCCOS Data Manager, nccos.data@noaa.gov, US DOC; NOAA; NOS; National Centers for Coastal Ocean Science (NCCOS)

Comment: This data documentation describes data files archived as a NOAA NCEI data accession, and is intended to provide dataset-level metadata for the purposes of discovery, use, and understanding.

Use Limitation: NOAA makes no warranty, expressed or implied, regarding these data, nor does the fact of distribution constitute such a warranty. NOAA cannot assume liability for any damages caused by any errors or omissions in these data.